Station Instructions 1

Attention Station
The Stroop Test

Step 1: Have your partner time you with the stopwatch as you take two tests.

Step 2: Start each test when your partner says, "Start." Your partner should stop timing when you say, "Done."

Step 3: For the first test, name the *colors* of the words on Test 1 as fast as you can (do NOT read the words!).

Step 4: For the second test, name the *colors* of the words on Test 2 as fast as you can (do NOT read the words!).

Step 5: When you are done, switch roles with your partner.

Step 6: Answer the questions about Station 1 on your Station Notes form.

Language Station
Word Puzzles

Step 1: Work by yourself to solve the word puzzles on one of the two cards.

Step 2: Trade cards with your partner.

Step 3: Work by yourself to solve the word puzzles on the second card.

Step 4: Compare and discuss your answers with your partner.

Step 5: Write your answers to the word puzzles on your Station Notes form.

Step 6: Answer the questions about Station 3 on your Station Notes form.

Station Instructions 2

Memory Station

Step 1:	Have your partner time you with the stopwatch as you play two games at this station.
Step 2:	Start each game when your partner says, "Start." Your partner should stop timing when you say, "Done."
Step 3:	For **Game 1**, flip over two cards at a time, leaving them turned over *only* if they match. If they do not match, you must flip them back and pick a different pair of cards. Match all the cards into pairs as quickly as possible.
Step 4:	When you are done with Game 1, flip the cards face down again WITHOUT SHUFFLING them.
Step 5:	Repeat Steps 1 through 3, complete with timing. This is **Game 2.**
Step 6:	Now SHUFFLE the cards and lay them out face down. Switch roles with your partner (you time while your partner plays the game).
Step 7:	Answer the questions about Station 2 on your Station Notes form.

Emotion Station

Step 1:	Look at Picture 1 while your partner looks at Picture 2.
Step 2:	Answer questions about this picture on your Station Notes form.
Step 3:	Now switch. Look at Picture 2 while your partner looks at Picture 1.
Step 4:	Answer questions about this picture on your Station Notes form.

Stroop Test Diagram

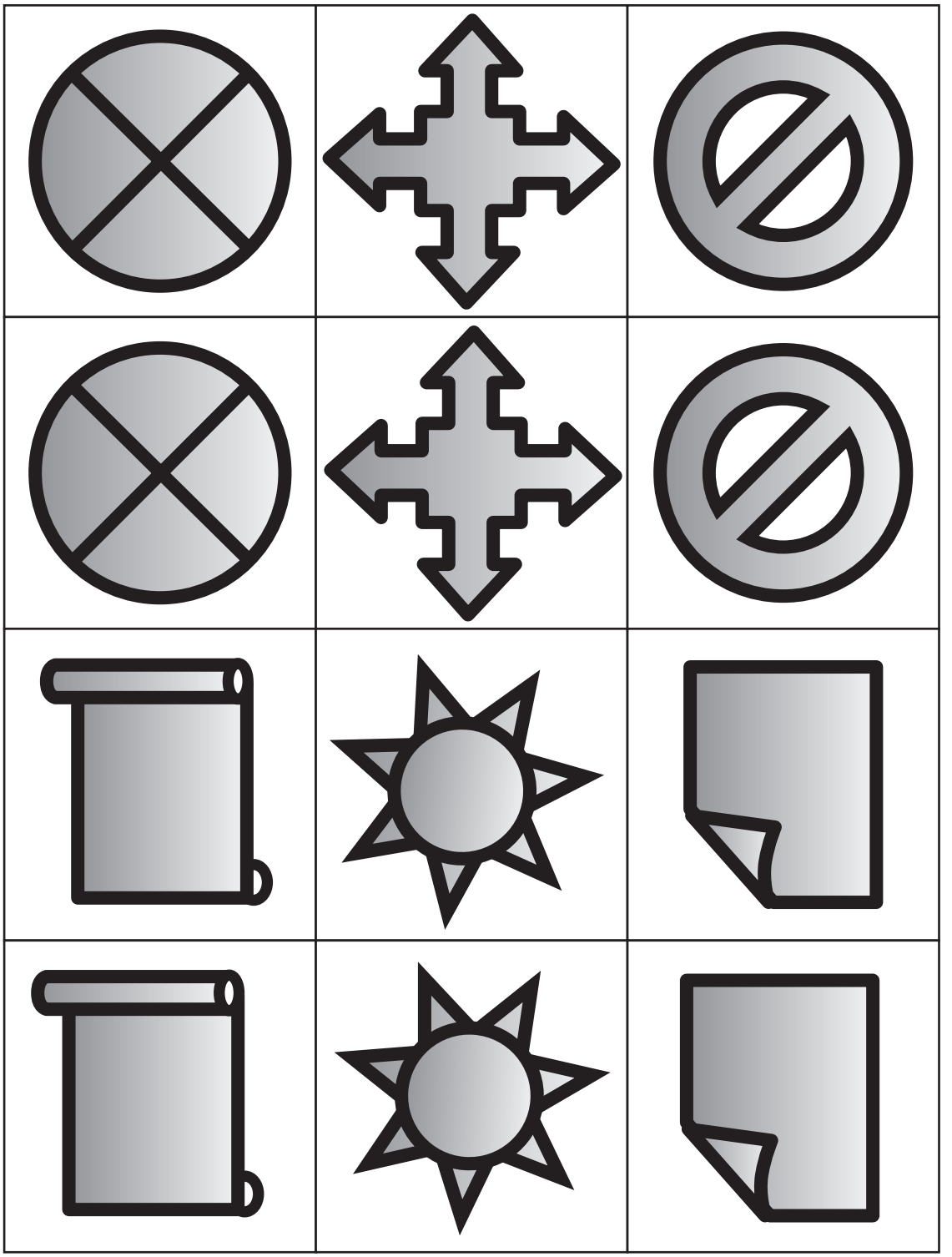
Test 1

Red	Blue	Green	Orange
Yellow	Blue	Purple	Green
Orange	Purple	Red	Red
Green	Yellow	Orange	Blue

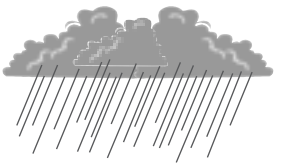
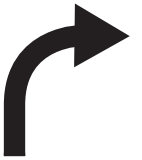
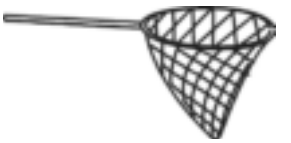
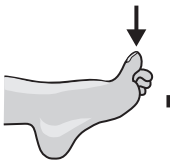
Test 2

Red	Blue	Green	Orange
Yellow	Blue	Purple	Green
Orange	Purple	Red	Red
Green	Yellow	Orange	Blue

Memory Station Game Cards



Word Puzzle Cards

1	b + 
2	in +  + 
3	 – d +  + r + 
4	cover / officer
5	Ame[made]rica
6	ev en ly

Station Notes

Name: _____ Date: _____

Station 1: Attention Station

Time to finish Test 1: _____ Test 2: _____

Which was harder, Test 1 or Test 2? Why do you think it was harder?

Station 2: Memory Station

Time to finish Game 1: _____ Game 2: _____

Which was easier, Game 1 or Game 2? Why do you think it was easier?

Station 3: Language Station

Answers to the word puzzles:

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

Which puzzles were easier for you (1, 2, and 3 *or* 4, 5, and 6)? Why do you think they were easier?

Station 4: Emotion Station

How did you feel after looking at Picture 1? Why did you feel this way?

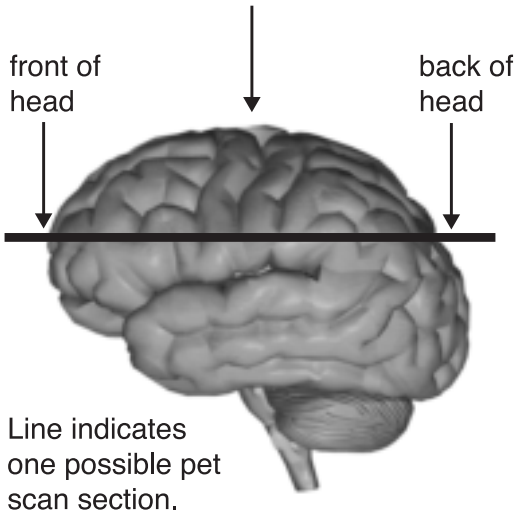
How did you feel after looking at Picture 2? Why did you feel this way?

Basics about PET Scans

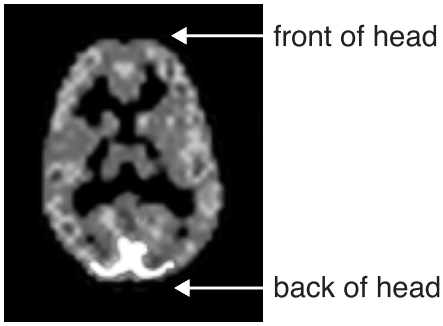
One way scientists study the brain is through positron emission tomography (PET) scans. PET scans allow scientists to create images of the brain in action. PET scans look like a slice of a person's brain.

The brain uses the sugar *glucose* for energy. The more active a brain area is, the more glucose it uses. Before they take a PET scan, trained scientists give people small amounts of radioactive glucose so they can see the glucose in their brain. The active parts of the brain appear as bright white spots in the image.

PET scan shows a top view of the brain.

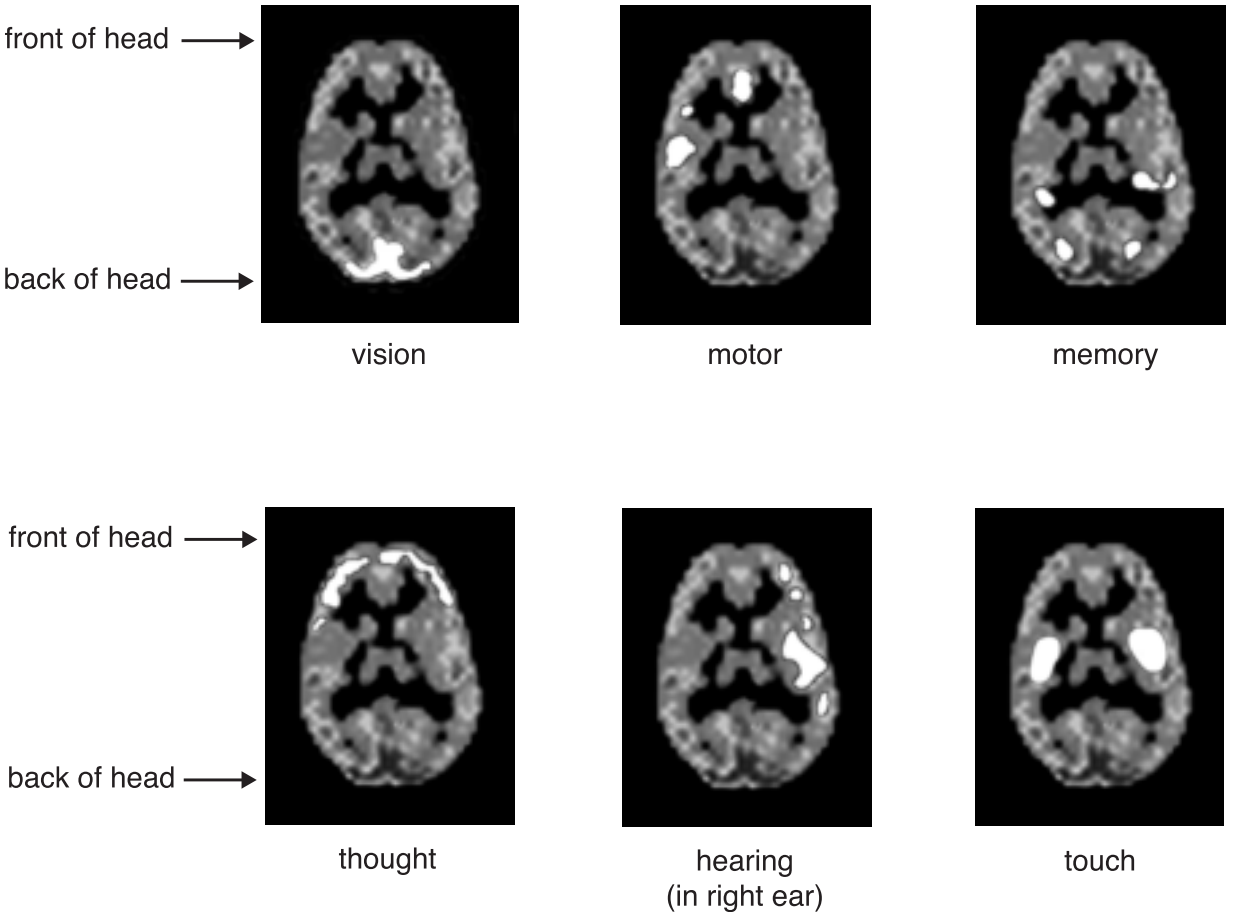


Line indicates one possible pet scan section.



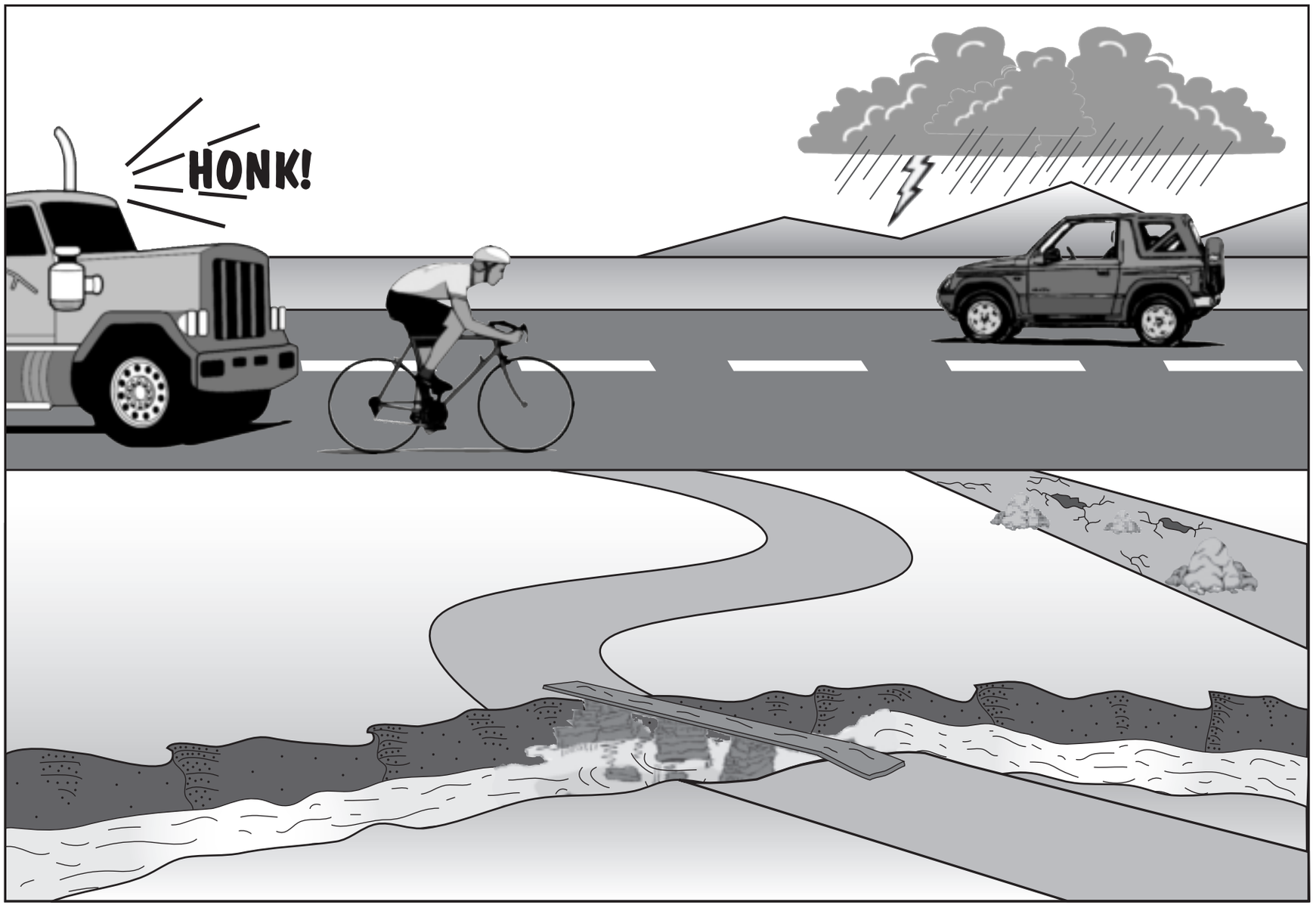
PET scan of a person processing visual information–view is from above the head.

Sample PET Scans



These PET scans show the brain as seen from above.

Scenario Diagram

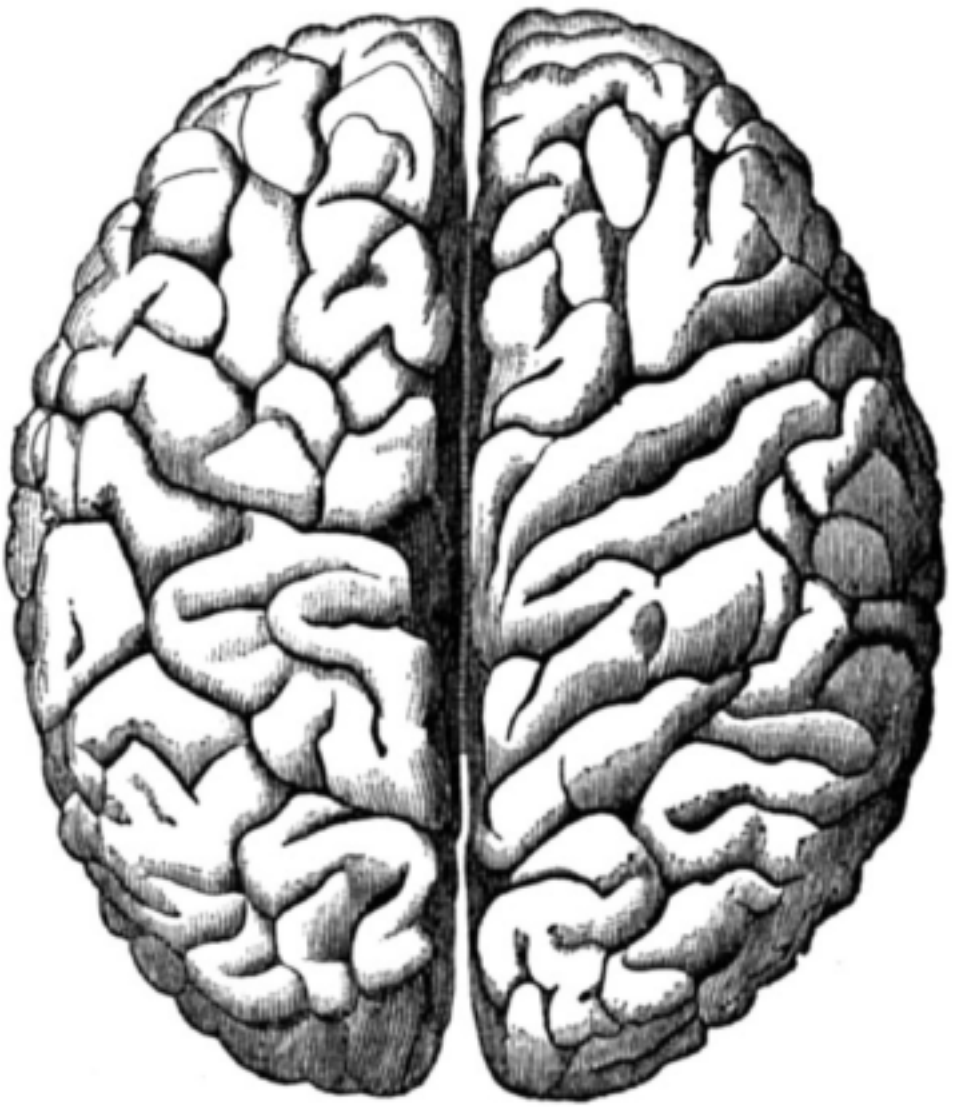


Master 2.3

Brain Outline

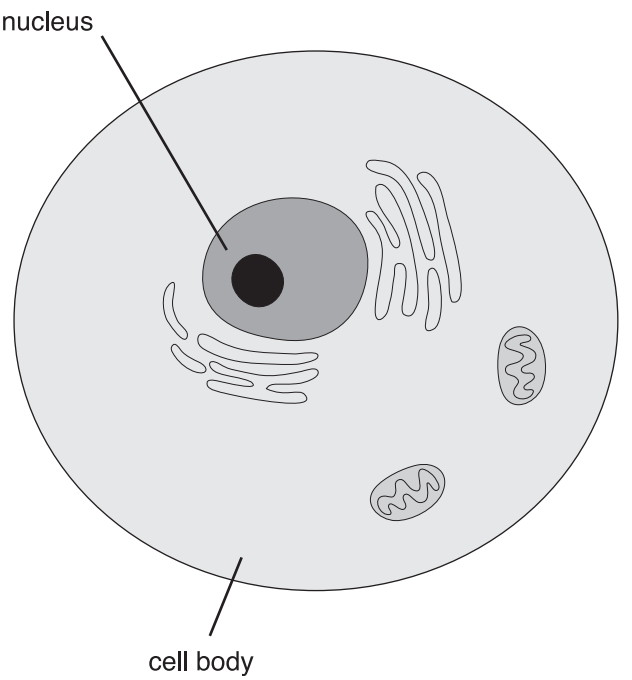
Name: _____ Date: _____

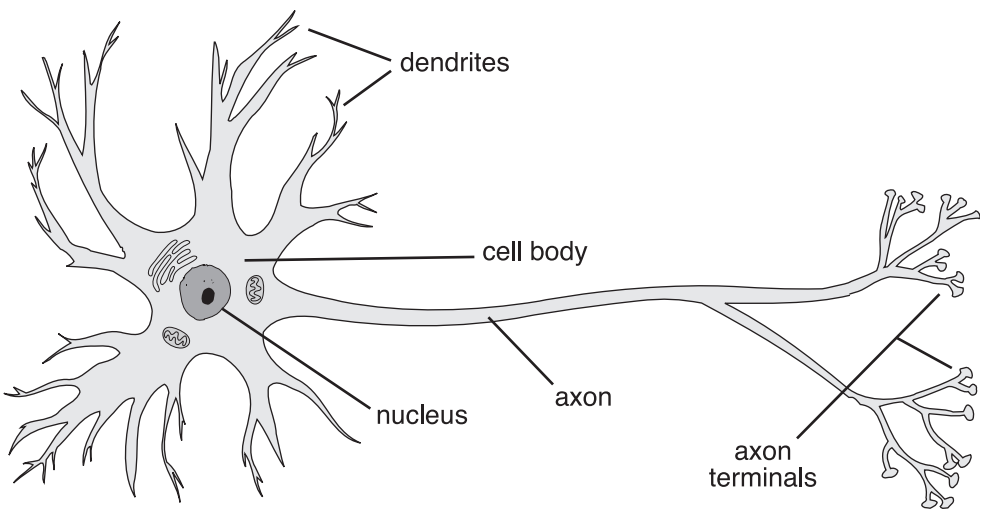
front of head



Master 2.4

Two Types of Cells





Master 3.1

Pathway-Building Worksheet

Name: _____ Date: _____

Pathway 1: Knee-Jerk Reflex

Draw your reflex pathway on the figure to the left. Label the parts you used. What is the function of each part?

When you tested your pathway, a spark traveled through the pathway showing the path of information flow. Describe the path of information flow through your pathway.

Pathway 2: Voluntary Leg Movement

Draw your voluntary leg movement pathway on the figure to the left. Label the parts you used. What is the function of each part?

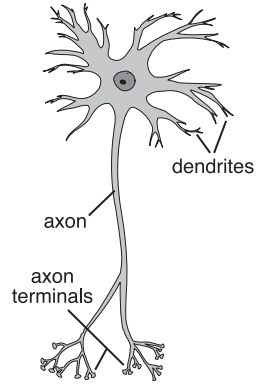
When you tested your pathway, a spark traveled through the pathway showing the path of information flow. Describe the path of information flow through your pathway.

Neuroscience Reference Manual

Part 1: The Central Nervous System

The Neuron

Neurons are cells that transport information. Like most cells, neurons have a cell body containing a nucleus. However, neurons also have special parts called **dendrites** and **axons**. Bundles of axons in the body are called **nerves.**



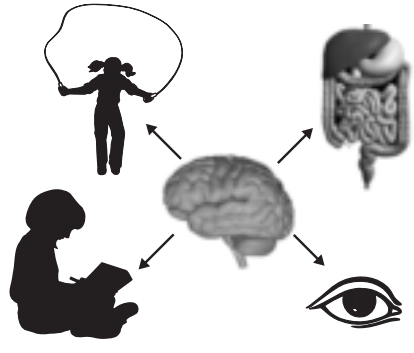
Dendrites pick up incoming signals and deliver them to the cell body. A neuron has many dendrites, so information can enter a neuron from many places at once.

Axons send signals out from the cell body. A neuron has one axon, but that axon may branch into many axon terminals. This allows information to be sent from one neuron to many places at once.

The Brain

The **brain** is a highly organized network of billions of cells protected by the skull. Information flows from all parts of the body to the brain.

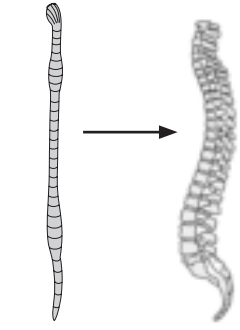
- The brain interprets this information.
- The brain then sends information out so the body can respond.



Voluntary actions, the things we choose to do, are directed by the brain. The brain also directs many **involuntary actions**. For instance, the brain controls blinking, heartbeat, and digestion.

The Spinal Cord

The **spinal cord** is a thin cord of neurons that is only about 1 inch in diameter …



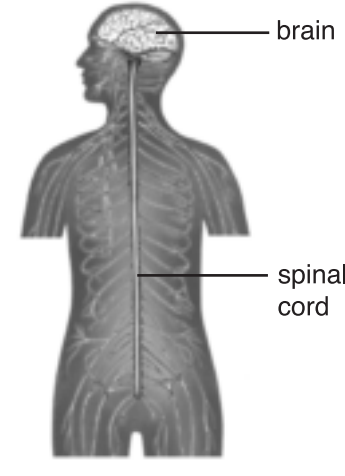
… protected by a series of bony disks called the **vertebral column**.

The spinal cord has two major functions:

- It allows information flow between the body and brain.
- It directs reflex and complex motor actions.

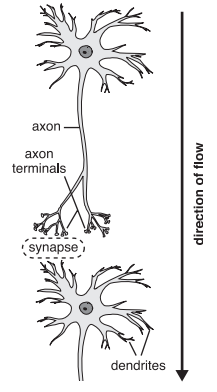
The Central Nervous System

The **central nervous system** is composed of the brain and the spinal cord:



Signaling

Neural signaling is the function of the nervous system. Each neuron



receives information through its **dendrites** from other neurons or from the environment,

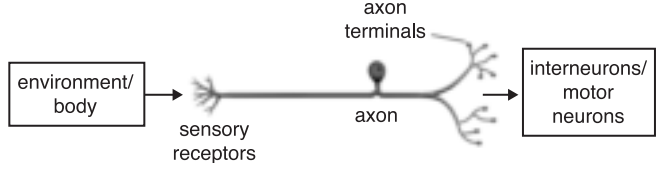
carries this information through its **cell body** and **axon** to its **axon terminals**, and

delivers it either to **the dendrites** of the next neuron in the pathway or to the **body**.

- Information travels in the form of an *electrical signal* from one end of a single neuron to the other end (the axon terminal).
- Only a tiny space separates one neuron from the next neuron in the pathway. This space, together with the axon terminal of the signal-transmitting neuron and the dendrite of the signal-receiving neuron, is called the *synapse*.
- Information crosses the synapse between neurons in the form of a *chemical signal*.

There are three major types of neurons in the nervous system: **sensory neurons**, **motor neurons**, and **interneurons**.

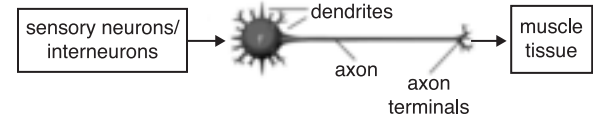
Sensory Neurons Carry Information from the Environment or the Body



Sensory neurons receive information from the *outside environment* or from *inside the body*.

Axons of sensory neurons then carry this information to other neurons located in the brain or spinal cord.

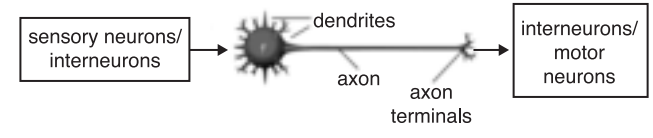
Motor Neurons Cause Actions



Motor neurons receive information from the axon terminals of *sensory neurons* or other *neurons*. The axons of motor neurons are often located in nerves together with axons of sensory neurons.

The **axon terminals** of motor neurons are located in *muscles*. The information delivered to muscle causes the muscle to contract.

Interneurons Carry Information within the Brain and Spinal Cord



Interneurons are neurons that are not motor neurons or sensory neurons.

The **dendrites** of interneurons receive signals from the axon terminals of *sensory neurons* or other *interneurons*.

The **axon terminals** of interneurons deliver information to other neurons.

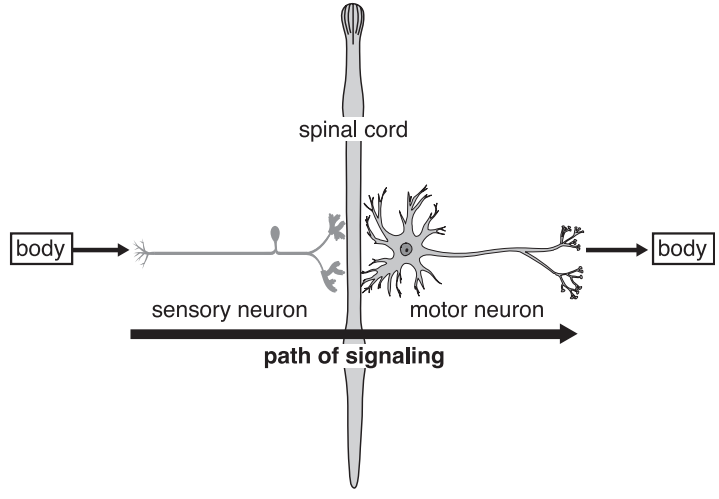
Reflex Actions

Sometimes the body must respond instantly to a signal from the environment.

If your hand touches a hot stove, you will pull your hand away without thinking about it. Such quick, automatic responses are called **reflex actions**.

Information flows more quickly through short pathways than long ones. We can respond more quickly when information does not have to go all the way to the brain. The neurons of reflex pathways can function without instructions from the brain. Information flows from the body to the spinal cord, then back out to the body, and the body protects itself. Although the brain is not involved in the reflex, it is informed about what is going on, so learning can occur.

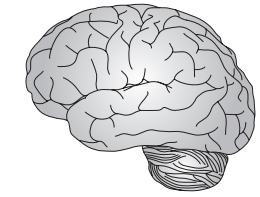
The simplest reflex pathways involve information flowing from a sensory neuron that connects to a motor neuron in the spinal cord.



Voluntary Actions

Voluntary actions, such as talking, eating, or walking, involve making a choice.

To make a choice, we use the **brain**.



Voluntary pathways require that information collected from sensory neurons goes to the brain. Interneurons carry information within the brain and spinal cord.

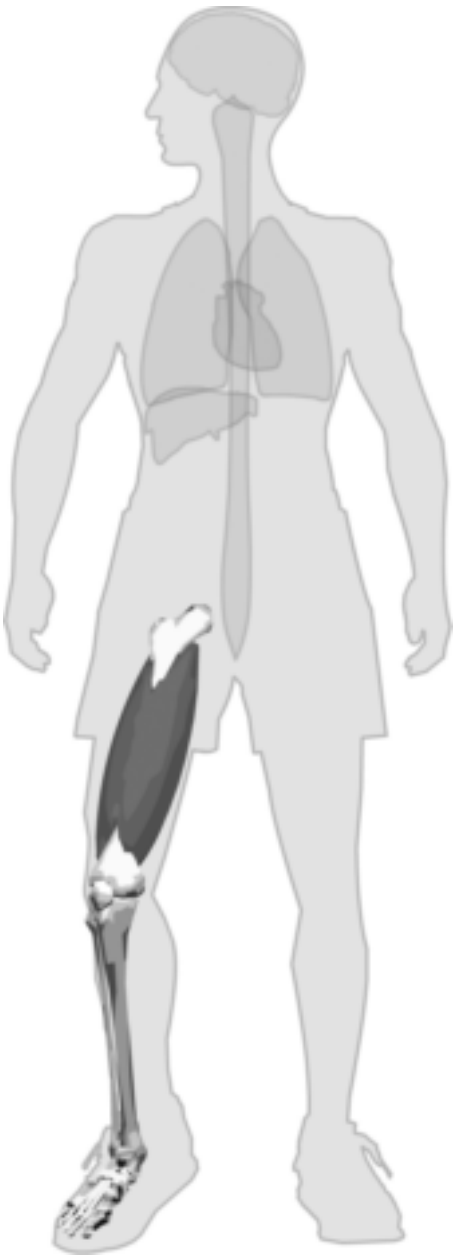
Information that activates a voluntary pathway can generate many different responses.

For instance, if someone stands near a chair, he or she can *choose* either to sit or to remain standing.

If sitting were a reflex, people would sit down any time they are near a chair.

Building a Reflex Pathway

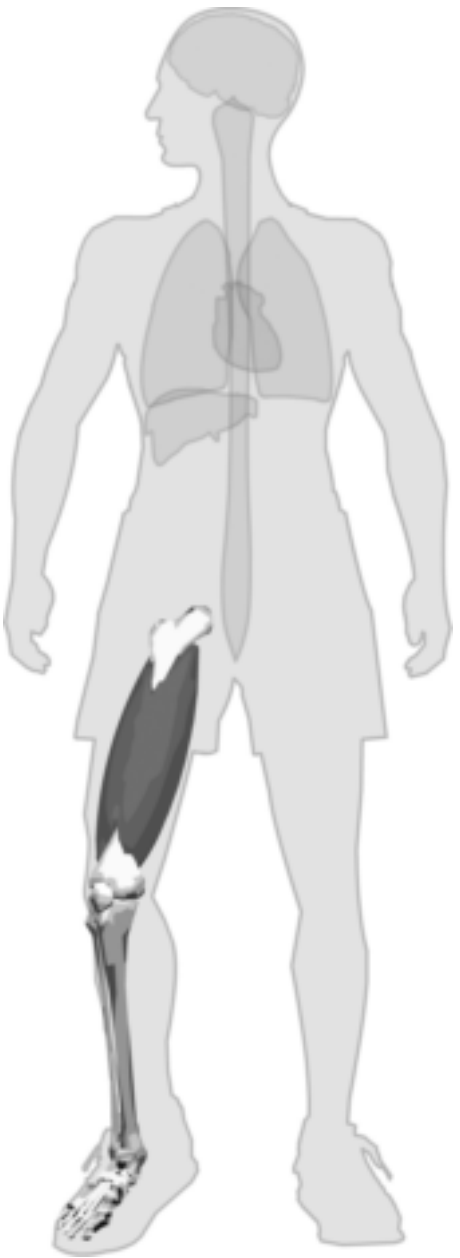
Names: _____ Date: _____



Master 3.4

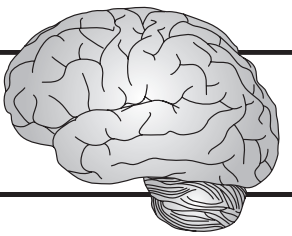
Building a Voluntary Response Pathway

Names: _____ Date: _____



Master 3.5

Memo from the Director



Learning Research Laboratory

Memo

TO: Research Scientists

FROM: Director of Research

RE: Research Grant

Congratulations everyone! We have received a grant from the National Learning Research Council to investigate factors that affect learning. We will use mice as our experimental model and performance on the Morris Water Maze as our measure of learning in mice.

Our three research questions are as follows:

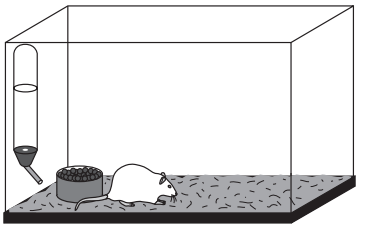
1. Does social interaction affect learning in mice?
2. Does an enriched environment affect learning in mice?
3. Does exercise affect learning in mice?

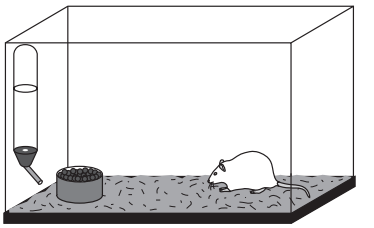
This research is very important in helping us understand factors that affect learning. Your hard work is greatly appreciated. I look forward to hearing about your results.

Morris Water Maze Data, Research Question 1 (Web Version)

Names: _____ Date: _____

Research Team #: _____



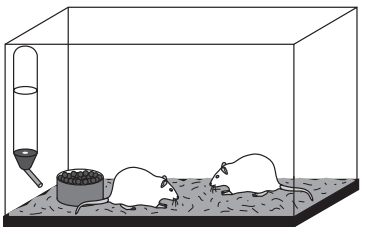


Morris Water Maze Data, Isolated Mice
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1I			
Mouse 2I			
Average for Isolated Mice			

Morris Water Maze Data, Socialized Mice
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1S			
Mouse 2S			
Average for Socialized Mice			

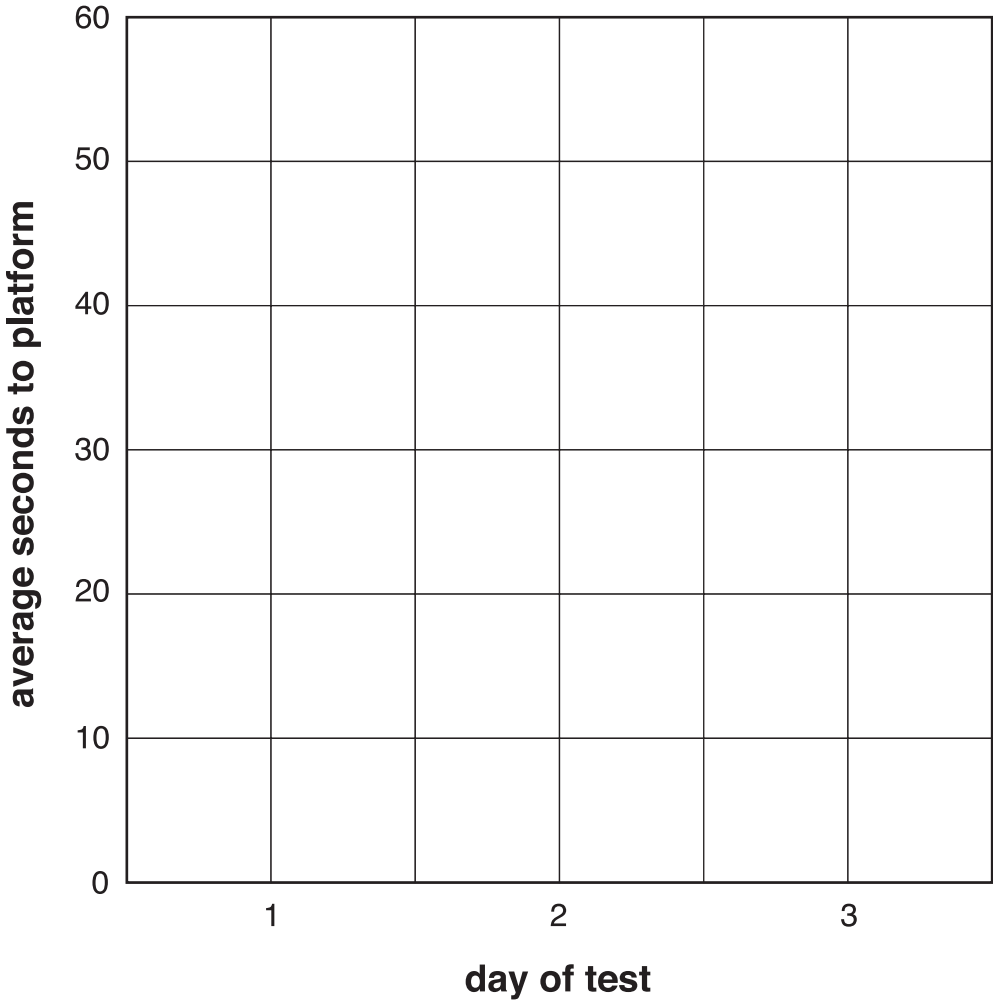


Morris Water Maze Results

Names: _____ Date: _____

Research Team #: _____

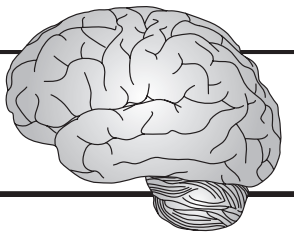
Title of Graph: _____



Legend

Master 4.3

Memo to the Director on Research Question 1



Learning Research Laboratory

Memo

TO: Director of Research
FROM: Research Team # _____
RE: Analysis of Results, Research Question 1

Below, we describe the experiment to answer Research Question 1, our analysis of the results, and our conclusions.

Research question—Does social interaction affect learning in mice?

Our hypothesis—Socialized mice learn more quickly than isolated mice.

Experiment—Our laboratory technician selected four genetically identical newborn mice from our Animal Care Facility. Two were raised in individual cages, while the other two were raised together in one cage. The performance of each adult mouse was tested over three consecutive days using the Morris Water Maze test.

Results and data analysis—See attached data table and graph.

Conclusions

Our hypothesis was (supported / not supported) by the data from our experiment.

Ways that learning in the isolated and socialized mice were similar: _____

_____

Ways that learning in the isolated and socialized mice were different: _____

_____

Our conclusion about learning from this experiment is that _____

_____

Scientific Research Reference Manual

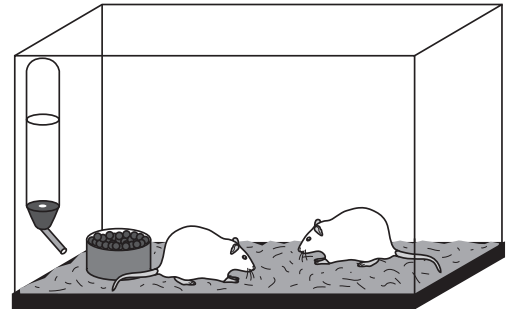
The Mouse: A Model System

Scientists use laboratory animals as *model systems* to study conditions that affect humans. A mouse is a good model system for a human because mice and humans both control their internal functions in about the same way and respond similarly to infection and injuries.

Using mice for research is less expensive and time-consuming than using humans. Researchers can control experimental conditions more easily for animals than for humans.

Raising Mice in the Laboratory

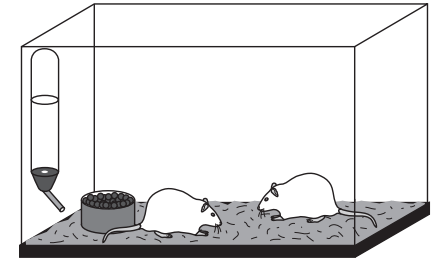
Researchers follow strict guidelines for ethical treatment of animals.



Mouse cages are checked daily to make sure mice have fresh food and water. Cages are kept clean and comfortable.

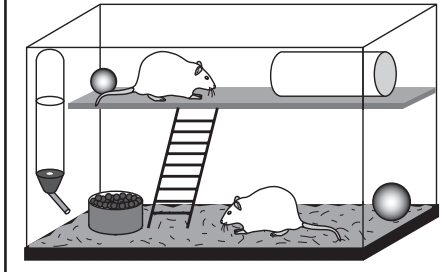
Mouse Cages

Mice are social animals that prefer to be housed together. The following examples show different living conditions.



standard cage

A standard mouse cage contains food, water, and bedding.



enriched cage

An enriched mouse cage contains food, water, bedding, and a variety of stimulating toys.

running wheel

A running wheel allows mice to exercise. Mice use it frequently when it is in their cage.

Scientific Research Reference Manual

Making a Hypothesis

A hypothesis is a testable statement that predicts a result. For example:

Mice raised in different types of cages will learn a task at different rates.

Researchers can make a specific hypothesis if they know something about the situation they are testing. For example, if they know that climbing ladders affects learning, they might make this hypothesis:

Mice raised in cages with ladders learn more quickly than mice raised in cages without ladders.

Designing the Right Experiment

Researchers identify experimental and control groups based on their hypothesis. Consider this hypothesis:

Mice that exercise learn more quickly than mice that do not exercise.

The **experimental group** is mice that use an exercise wheel. The **control group** is mice that do not use an exercise wheel, because exercise wheels are not provided under standard laboratory conditions.

All other conditions are the same for both groups.

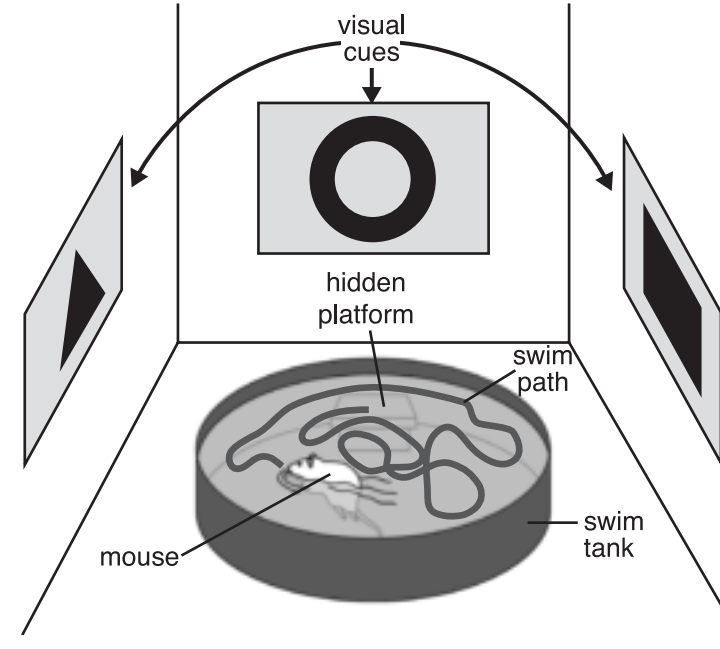
control group cage

experimental group cage

Measuring Learning in Mice

Learning in mice can be measured using the Morris Water Maze test. In this test, mice are placed in a swim tank filled with water in which powdered milk has been dissolved. The cloudiness of the water prevents the mice from seeing a platform just under the surface of the water. A mouse standing on the platform can keep its head above water. Mice prefer standing on the platform to swimming in the tank. When mice are placed in the tank, they swim around until they find the platform. The mice use visual cues placed around the room to orient themselves while they are inside the tank.

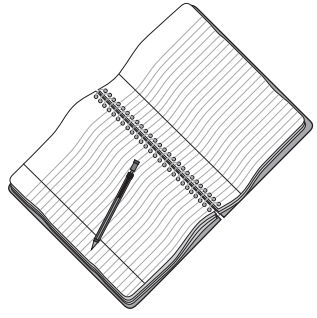
The Morris Water Maze



Scientific Research Reference Manual

Gathering Data

Data are the results of experiments. Scientists write down data as they conduct their experiment. They record their data in a lab notebook, which can be on paper or on the computer.

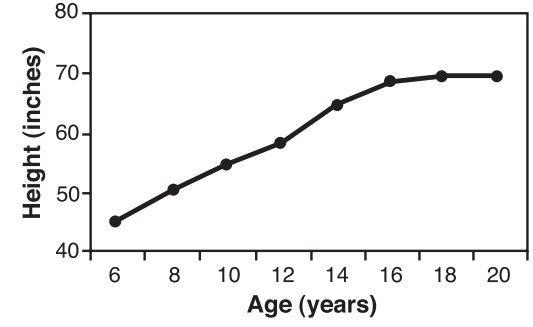


Analyzing Data

After scientists complete experiments, they analyze their data. Scientists look at all of the data they have collected. The high and low values give them the range of the results. Scientists may calculate data averages. Averages even out natural variations that occur when measures are made across time or across individuals. The average provides scientists with an approximation of a "true" value for the measure.

Mouse #	Length of Swim Path, Day 1
1	56 cm
2	45 cm
3	49 cm
Average	**(56 + 45 + 49)/3 = 50 cm**

Interpreting Data



Graphs help scientists interpret their results by providing a picture of the results. Scientists use graphs to identify trends or patterns in the results of their experiments.

Drawing Conclusions

Because the hypothesis and experiment are based on a research question, you should ask,

Do the results from the experiment provide an answer for the research question?

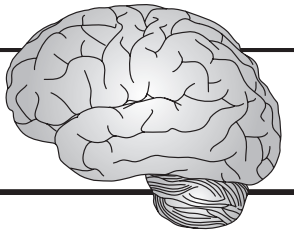
If the answer is "No" or "I don't know," the experiment was probably not designed correctly. Think about the question and redesign the experiment.

If the answer is "Yes," ask,

Do the results support the hypothesis?

Whether the answer is "Yes" or "No," the research question has been answered. Use evidence from the experiment to defend that answer.

Memo from Lab Technician



Learning Research Laboratory

Memo

TO: Research Scientists
FROM: Lab Technician
RE: Experimental Design, Research Question 1

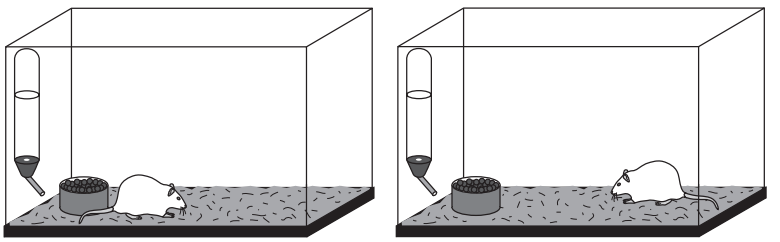
I have designed and run an experiment to answer research question 1. Before you analyze the data, please review my notes on the design of the experiment.

Experimental Design

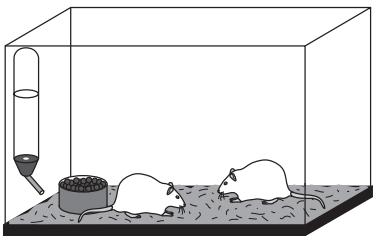
Research Question: Does social interaction affect learning in mice?

Hypothesis: Socialized mice learn more quickly than isolated mice.

Procedure: I selected four genetically identical newborn mice from our Animal Care Facility. Two were raised in individual cages (Isolated), while the other two were raised together in one cage (Socialized). After they were fully grown, I tested the performance all four adult mice once a day for three consecutive days using the Morris Water Maze test.



isolated

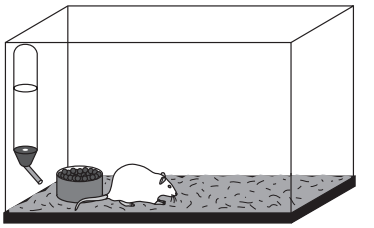


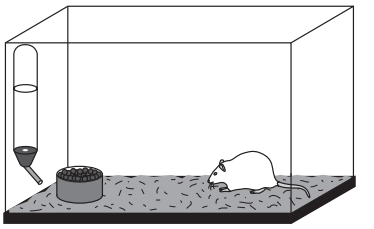
socialized

Morris Water Maze Data, Research Question 1 (Print Version)

Names: _____ Date: _____

Research Team #: _____



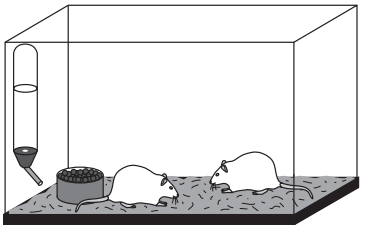


Morris Water Maze Data, Isolated Mice
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1I	50 seconds	34 seconds	33 seconds
Mouse 2I	50 seconds	37 seconds	32 seconds
Average for Isolated Mice			

Morris Water Maze Data, Socialized Mice
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1S	50 seconds	32 seconds	27 seconds
Mouse 2S	50 seconds	33 seconds	30 seconds
Average for Socialized Mice			



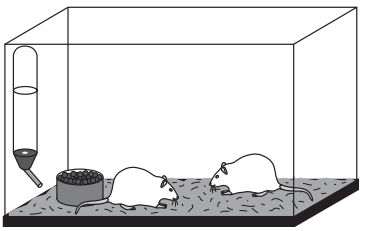
Morris Water Maze Data, Research Questions 2 and 3 (Web Version)

Names: _____ Date: _____

Research Team #: _____

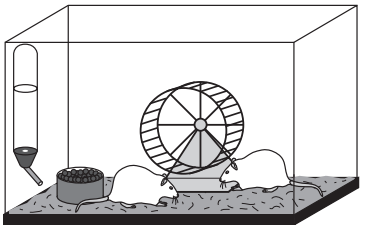
Morris Water Maze Data, Standard Cage
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1S			
Mouse 2S			
Average			



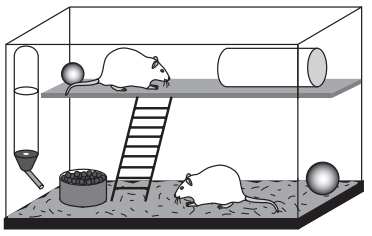
Morris Water Maze Data, Standard Cage with Running Wheel
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1SR			
Mouse 2SR			
Average			



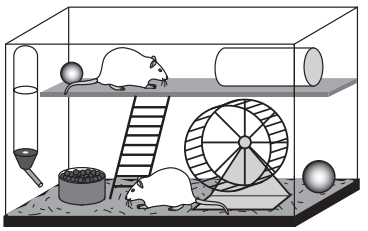
Morris Water Maze Data, Enriched Cage
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1E			
Mouse 2E			
Average			

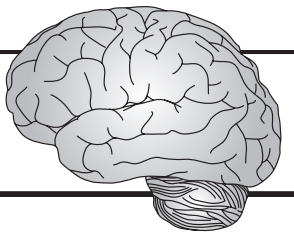


Morris Water Maze Data, Enriched Cage with Running Wheel
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1ER			
Mouse 2ER			
Average			



Memo to the Director on Research Question 2



Learning Research Laboratory

Memo

TO: Director of Research
FROM: Research Team # _____
RE: Results, Research Question 2

Below, we describe the experiment to answer Research Question 2, our analysis of the results, and our conclusions.

Research question—Does an enriched environment affect learning in mice?

Our hypothesis—_____

_____

Experiment—We selected four infant mice and raised them in pairs in each of the following two conditions:

_____ Standard Cage
_____ Enriched Cage
_____ Standard Cage with Running Wheel
_____ Enriched Cage with Running Wheel

The performance of each adult mouse was tested over three consecutive days using the Morris Water Maze test.

Results and data analysis—See attached data table and graph.

Conclusions

Our hypothesis was (supported / not supported) by the data from our experiment.

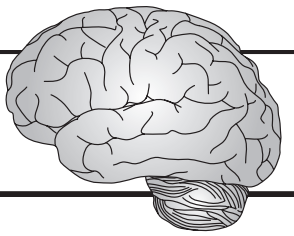
Ways that an enriched environment affected learning in mice: _____

_____

Our conclusion about learning from this experiment is that _____

_____

Memo to the Director on Research Question 3



Learning Research Laboratory

Memo

TO: Director of Research
FROM: Research Team # _____
RE: Results, Research Question 3

Below, we describe the experiment to answer Research Question 3, our analysis of the results, and our conclusions.

Research question—Does exercise affect learning in mice?

Our hypothesis— _____

_____

Experiment—We selected four infant mice and raised them in pairs in each of the following two conditions:

_____ Standard Cage
_____ Enriched Cage
_____ Standard Cage with Running Wheel
_____ Enriched Cage with Running Wheel

The performance of each adult mouse was tested over three consecutive days using the Morris Water Maze test.

Results and data analysis—See attached data table and graph.

Conclusions

Our hypothesis was (supported / not supported) by the data from our experiment.

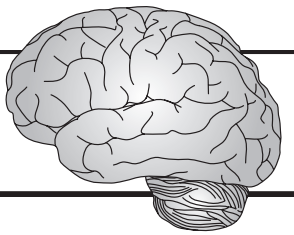
Ways that exercise affected learning in mice: _____

_____

Our conclusion about learning from this experiment is that _____

_____

Summary of Research Findings



Learning Research Laboratory

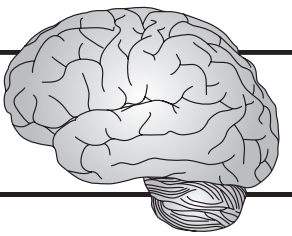
Research Questions

1. Does social interaction affect learning in mice?

2. Does an enriched environment affect learning in mice?

3. Does exercise affect learning in mice?

Next Research Assignment



Learning Research Laboratory

Memo

TO: Research Scientists

FROM: Director of Research

RE: Next Assignment

Excellent work everyone! Thank you for analyzing the experimental data to answer Research Question 1. Now let's move on to Research Questions 2 and 3.

Even-numbered teams, please work on Research Question 2:

> Does an enriched environment affect learning in mice?

Odd-numbered teams, please work on Research Question 3:

> Does exercise affect learning in mice?

Once again, I greatly appreciate your hard work. I look forward to hearing about your results.

Experimental Design

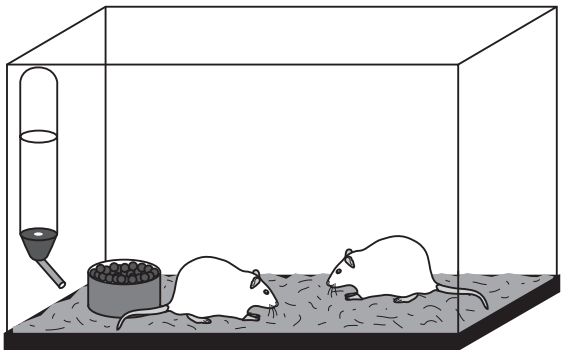
Names: _____ Date: _____

Research Team #: _____

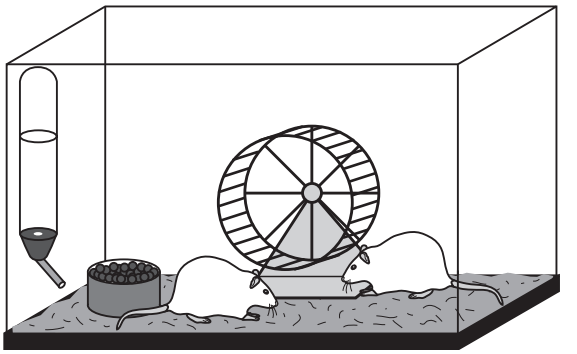
Research Question: _____

Hypothesis: _____

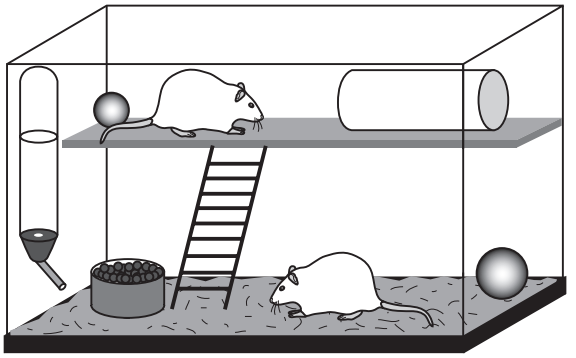
Procedure: Four genetically identical infant mice were selected. Mice were raised in pairs under each of the two conditions circled below. The performance of each adult mouse was tested over three consecutive days using the Morris Water Maze test.



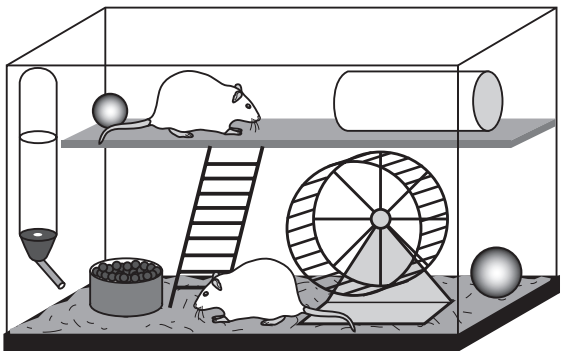
standard cage



standard cage with running wheel



enriched cage



enriched cage with running wheel

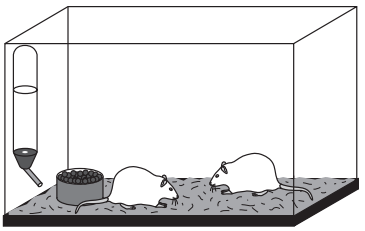
Morris Water Maze Data, Research Questions 2 and 3 (Print Version)

Names: _____ Date: _____

Research Team #: _____

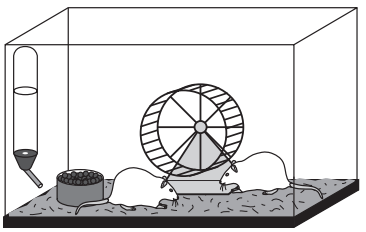
Morris Water Maze Data, Standard Cage
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1S	50 s	32 s	27 s
Mouse 2S	50 s	33 s	30 s
Average			



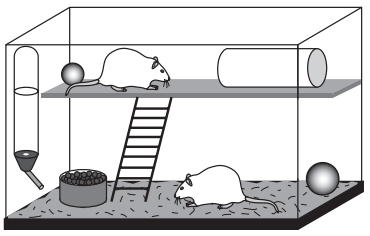
Morris Water Maze Data, Standard Cage with Running Wheel
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1SR	50 s	24 s	17 s
Mouse 2SR	50 s	25 s	20 s
Average			



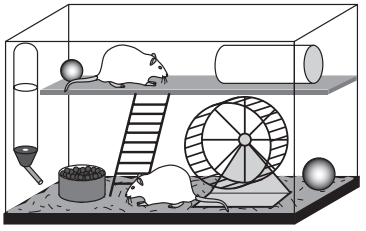
Morris Water Maze Data, Enriched Cage
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1E	50 s	38 s	29 s
Mouse 2E	50 s	36 s	25 s
Average			



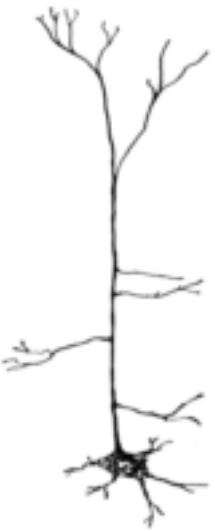
Morris Water Maze Data, Enriched Cage with Running Wheel
Time to Platform

	Day 1	Day 2	Day 3
Mouse 1ER	50 s	26 s	22 s
Mouse 2ER	50 s	27 s	20 s
Average			

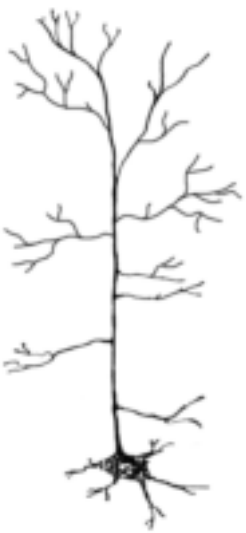


Neuron Structure Data

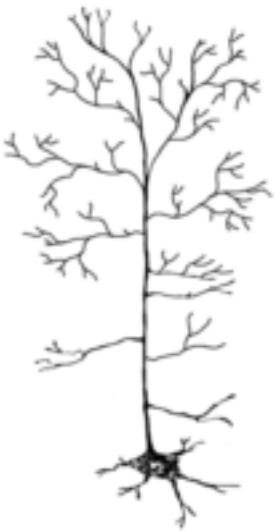
Mouse 1: Standard Cage,
No Water Maze Activity



Mouse 2: Standard Cage,
Practiced Morris Water Maze



Mouse 3: Enriched Cage,
No Water Maze Activity



Mouse 4: Enriched Cage,
Practiced Morris Water Maze

The brain contains your sense of self; it makes you who you are.

Case Study—John M.

John has always been one of my favorite patients. Outgoing and well-liked, John excelled at academics and athletics. Captain of the football team at his high school, he went on to become a star quarterback at his college. The whole town was heartbroken when John injured his spine on the football field and was told he would never walk again. I was very worried that John would lose hope for his life—after all, he was only 22 at the time of his injury.

But John surprised us all by devoting himself to his physical therapy and his schoolwork. He has always had a special knack for physics; after his injury, he completed a tough honors physics program in his remaining years of college. This spring, John graduated at the top of his class, and even won a fellowship for graduate work in particle physics! In addition, he has won several Wheelchair Olympics events in our town over the past three years. John is an inspiration to us all.

Three Case Studies

Case Study—Frank L.
Angelica brought her 54-year-old husband, Frank, to my office last year. Frank had been a devoted police sergeant and husband. Then a burglar shot him in the head. He had emergency surgery to remove a bullet from his brain. Frank recovered physically; he could walk, talk, and take care of himself as he did before. However, he had a great sense of humor before his injury. He loved watching comedy movies with Angelica. Now Frank says he doesn't enjoy movies. He doesn't find many things funny. Before the injury, Frank was a calm, friendly man. Now he is angry all the time. Sometimes Frank smashes things in the house and yells at anyone in sight. Both Frank and Angelica are unhappy.

Case Study—Lisa R.
Lisa is an energetic 36-year-old librarian. She loves her job. Lisa is also blind. She received a blow to the back of her head in a car accident several years ago. The injury caused her loss of sight. She had always enjoyed teaching children's activities at the library. Now she teaches in a special program for blind children. Lisa encourages the children to practice reading because books open new worlds to everyone. The library has become the best source for Braille books in the state. Lisa is very proud of her accomplishments.

Case Study—Mandy T.
Mandy is 78, and she has been my patient for the past 15 years. Her son Kevin has brought her to my office for the past three years. Mandy has Alzheimer's disease, a brain disease that causes memory loss, confusion, and unstable emotions. She no longer knows who I am or why "this strange man" (Kevin) has brought her to the clinic. She swears, complains loudly, and has frequent outbursts of anger at Kevin and me. It is hard for Kevin to see his mother this way. He remembers her as a gentle, kind, and caring mother who took care of everyone around her.